CONTROL GOLF BALL – DDH Steel Control

CROSS-REFERENCE TO RELATED APPLICATIONS

A claim of benefit is made to provisional application number 60/212,251 filed on June 19, 2000, which is herein incorporated by reference.

BACKGROUND OF THE INVENTION

The instant invention is directed to golf balls, and more particularly to a ball having the optimal core compression, core diameter, cover hardness, and dimple configuration to provide superior playability capabilities with respect to softness and spin without sacrificing superior distance capabilities.

DESCRIPTION OF THE PRIOR ART

There are a number of physical properties that affect the performance of a golf ball. The core of the golf ball is the source of the ball's energy. Among other things, the core affects the ball's "feel" and its initial velocity. The "feel" is the overall sensation transmitted to the golfer through the golf ball after striking a ball. The initial velocity is the velocity at which the golf ball travels when first struck by the golf club. The initial velocity, together with the ball's trajectory, determine how far a shot will travel.

Until the late 1960's most golf balls were constructed as three-piece wound balls. In the three-piece wound ball, a solid or liquid-filled center is wound with rubber windings to form a core, which is then covered with a cover of compounds based on natural (balata or guttta percha) or synthetic transpolyisoprene. During

the manufacturing process, after the liquid-filled center is formed, it is frozen to make it as hard as possible so that it will retain its spherical shape while the rubber thread is wrapped around it.

These three-piece wound balls were known and are still known to provide acceptable flight distance and soft feel. Additionally, due to the relative softness of the balata cover, skilled golfers are able to impart various spins on the ball in order to control the ball's flight path (e.g. "fade" or "draw") and check characteristics upon landing on a green.

With the advent of new materials developed through advances and experimentation in polymer chemistry, two-piece golf balls were developed. The primary difference between a two-piece golf ball and a three-piece golf ball is the elimination of the rubber thread windings found in the three-piece balls. A relatively large solid core in a two-piece ball takes the place of the relatively small center and thread windings of a three-piece ball core having the same overall diameter. With the elimination of the thread windings, there is no need to freeze the core during the manufacturing process of the two-piece golf ball.

Two-piece balls have proven to be more durable than three-piece balls when repeatedly struck with golf clubs and more durable when exposed to a variety of environmental conditions. An example of these environmental conditions is the high temperature commonly experienced in an automobile trunk. In addition, two piece balls are typically less expensive to manufacture than the three-piece wound balls. However, two-piece balls are, in general, considered to have inferior characteristics of feel and workability when compared to three-piece balls.

Generally and historically, two piece balls use harder cover materials for increased durability. The "hardness" of a golf ball can affect the "feel" of a ball and the sound or "click" produced at contact. "Feel" is determined as the deformation (i.e. compression) of the ball under various load conditions applied across the ball's diameter. Generally, the lower the compression value, the softer the "feel." Consequently, two-piece golf balls have a higher initial velocity. In addition, typically two-piece golf balls have more potential energy, which is derived primarily from the core. The cores in two piece golf balls are typically larger than the centers in three-piece golf balls.

In contrast, three-piece golf balls with their smaller centers historically use softer cover materials. These softer cover materials result in a lower initial velocity when compared to two-piece golf balls. However, this difference in the initial velocity may be somewhat made up by the windings in the three-piece golf ball.

In addition to manipulating the core and cover of a golf ball, for many years golf balls have been made with surface indentations or depressions, called dimples, to improve their aerodynamic properties in flight. Specifically, ball manufacturers have looked to dimple configurations in an effort to design a ball with superior distance capabilities. Many efforts have been made to select the optimum number, size and shape of dimples as well as their disposition around the outer surface of a generally spherically shaped golf ball.

Ball manufacturers are bound by regulations of the United States Golf Association (USGA) which control many characteristics of the ball, including the size and weight of the ball, the initial velocity of the ball when tested under

specified conditions, the overall distance the ball travels when hit under specified test conditions, and the ball's aerodynamic symmetry. Under USGA regulations, the diameter of the ball cannot be less than 1.680 inches, the weight of the ball cannot be greater than 1.620 ounces avoirdupois, the initial velocity of the ball cannot be greater than 250 feet per second when tested under specified conditions (with a maximum tolerance of +2%), the driver distance cannot exceed 280 yards when tested under specified conditions (with a test tolerance of +6%), and the ball must perform the same aerodynamically regardless of orientation.

While the USGA sets a limit for the distance a ball can travel under set test conditions, there is no upper limit on how far a player can hit a ball. For example, U.S. Patent No. 4,142,727 to Shaw discloses the projection of a dodecahedron onto the ball as a basis for a dimple configuration in one of their preferred embodiments. The dodecahedron is formed by the projection of twelve (12) pentagons onto the balls surface. The preferred ball disclosed in this reference has a minimum of five (5) uninterrupted great circle paths present on the dimpled ball, and a major portion of the dimples present on the ball are within the boundaries of either a triangle, rhombus or pentagon.

In U.S. Patent No. 5,192,078 to Woo discloses the use of a dodecahedron pattern in one of it preferred embodiments. The ball has six great circle paths which are free of dimples to further subdivide its surface pattern.

A problem with the prior art dimple configurations is that they fail to take into account other features of the ball, such as core size, core compression and cover hardness, which also influence how far a ball will travel.

U.S. Patent No. 5,368,304 to Sullivan discloses a ball having a low spin rate, which in turn enables the ball to travel greater distances. According to the Sullivan patent, the low spin rate is the result of a soft core and hard cover. While the '304 patent discloses the use of a soft core and hard cover to lower the spin rate, it does not disclose a dimple configuration for the ball.

The primary properties associated with golf ball performance are resilience and hardness. The coefficient of restitution (C.O.R.), which is the ratio of the relative velocity of two spheres before and after direct impact is used to determine the resilience of a golf ball. The C.O.R. is measured on a scale of zero to one, with one being a perfectly elastic collision and zero an inelastic collision.

The C.O.R. of a golf ball is a function of the properties of its core and cover combination. The golf ball with a higher measured C.O.R. performs better than other golf balls with a lower measured value. Materials with a C.O.R. of 0.700 and above are useful as a cover material. Materials with a C.O.R. of .715 are considered to have superior performance as a golf cover.

OBJECT OF THE INVENTION

Accordingly, it is an object of the instant invention to provide a two-piece golf ball that has a soft feel in combination with superior distance capabilities.

It is another object of the instant invention to optimize the combination of core compression, core size, core composition, dimple configuration, cover composition, and cover hardness to provide a two-piece golf ball, which travels great distances, and at the same time complies with USGA regulations.

It is yet another object of the instant invention to provide a two-piece golf ball having a synthetic cover material that achieves the sound, feel, playability and flight performance qualities of balata covered golf balls.

It is a further object of the instant invention to lower the cost of manufacturing a two-piece golf ball that has a soft feel in combination with superior distance capabilities.

It is still a further object of the instant invention is to provide a two-piece golf ball having superior distance, trajectory and flight stability.

Another object of the instant invention is to provide a two-piece golf ball having a surface divided into a plurality of pentagonal configurations or shapes for the location of dimples for enhancing the aerodynamic properties of the golf ball.

SUMMARY OF THE INVENTION

The invention achieves the above-described objectives by providing a two-piece golf ball having a solid rubber core, a synthetic ionomer resin cover, and a "dodecahedron" dimple pattern. The ball of one embodiment of the instant invention has a core compression in the range of 68 PGA to 75 PGA; a core diameter in the range of about 1.535 inches to about 1.545 inches; a core with a C.O.R. value of 0.690 to 0.710; a cover hardness in the range of about 60 Shore D to about 70 Shore D, and a dimple pattern based on the geometry of a dodecahedron. This combination has been found to produce a ball with superior distance capabilities, which also satisfies USGA regulations. The use of these properties in the golf ball of the instant invention is based on the recognition that it is

the combination of the core compression, core composition, core size, cover composition, cover hardness, dimple configuration, dimple size and dimple shape that will produce a ball that will travel the greatest distance without compromising shot-making feel.

The cover material should be constructed from a relatively stiff material, for example, synthetic thermoplastic materials. Most notably these synthetic thermoplastic materials are ionomeric resins. Ionomeric resins are polymers containing interchain ionic bonding. As is well known in the chemical arts, ionomeric resins are generally ionic copolymers of an olefin having from about two to about eight carbon atoms, such as ethylene and a metal salt of an unsaturated carboxylic acid, such as acrylic acid, methacrylic acid, or maleic acid. The pendent ionic groups in the ionomeric resins interact to form ion-rich aggregates contained in a non-polar polymer matrix. Metal ions, such as sodium, lithium, zinc or magnesium are used to neutralize some portion of the acidic groups in the copolymer. This results in a thermoplastic elastomer, which exhibits enhanced flight characteristics and durability when compared to golf balls constructed with balata covers. However, the advantages gained by enhanced durability have been offset by the decreased playability properties. The instant invention addresses the playability shortcomings of earlier ionomer covers.

The ionomers used in the cover composition are sold by E.I. Dupont De Nemours & Company under the name SURLYN. In an attempt to overcome the negative factors of the hard ionomer covers, DuPont introduced low modulus SURLYN ionomers in the early 1980's. These SURLYN ionomers have a flexural

modulus of from about 3000 to about 7000 PSI and hardness of from 25 to about 40 as measured on the Shore D scale - ASTM 2240. The low modulus ionomers are terpolymers, typically of ethylene, methacrylic acid and n- or iso-butylacrylate, neutralized with sodium, zinc, magnesium or lithium cations. E.I. DuPont De Nemours & Company has disclosed that the low modulus ionomers can be blended with other grades of previously commercialized ionomers of high flexural modulus from about 30,000 to 55,000 PSI to produce balata-like properties. However, soft blends, typically 52 Shore D and lower (balata-like hardness) are still prone to cut and shear damage.

The low modulus ionomers when used without high flexural modulus blends produce covers with very similar physical properties to those of balata, including poor cut and shear resistance. Worse, wound balls with these covers tend to go "out-of-round" quicker than wound balls with balata covers. Blending with hard SURLYN ionomers was found to improve these properties.

These new grade of SURLYN ionomers have a high flexural modulus in the range of 60,000 PSI to 80,000 PSI, sodium metal ions are used to partially neutralize a moderate amount of acid groups. Furthermore the higher modulus SURLYN grades have a hardness of from 60 to about 70 as measured on the Shore D scale - ASTM 2240.

It has now been discovered that a blend of high modulus ionomers with an associated high acid level and partially neutralized by sodium with a very low modulus ionomer containing a low acid level partially neutralized by zinc results in a golf ball cover with improved playability characteristics. For the purposes of the

SURLYN ionomer resin grade designations, a low acid level is approximately 12% by weight, a medium acid level is approximately 15% by weight, and a high acid level is approximately 19% by weight.

As mentioned previously, dimples are preferably circular in shape, but can have a non-circular shape within the scope of this invention.

The combination of the aforementioned core, cover and dimple specifications produces a golf ball that possesses noticeable improvements in playability (i.e. spin properties) without sacrificing the ball's durability (i.e. impact resistance etc.) which in turn relates directly to the distance a ball will travel when struck. In addition, the instant invention provides a golf ball composition that exhibits the desired properties of the three-piece wound ball (e.g. long distance in combination with a soft feel), but with the lower manufacture cost associated with the two-piece ball. These and other objects of the instant invention will be apparent from a reading of the following detailed description of the instant invention.

BRIEF DESCRIPTION OF THE DRAWING

Figure 1 is a sectional view of a golf ball made in accordance with one embodiment of the invention.

Figure 2 is an elevation view of the outer surface of a golf ball being divided into a plurality of polygonal configurations according to the invention.

Figure 3 is a polar view of the pentagons projected onto the surface of the ball

Figure 4. is the ball with great circles projected upon the surface.

Figure 5 is a pentagon that is further subdivided by great circles.

Figure 6 is an equatorial view of pentagons being projected onto the surface of the ball.

Figure 7 is a polar view of pentagons projected upon the balls surface.

Figure 8 is a view of a pentagon further subdivided into triangles and rows.

Figure 9 is a cross sectional view cut through one of the dimples on the outer surface of the ball.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Fig. 1 shows a section view of a two-piece golf ball made in accordance with the preferred embodiment of the instant invention. A two-piece golf ball has a solid rubber core 2 and a cover 4. The solid rubber core 2 is manufactured by using conventional compression molding processes. The components are mixed together and extruded to produce pre-forms, which are then placed in cavities in the mold and are compression molded under pressure and cured/vulcanized to form cores. The same mix may also be injection molded. Curing is carried out in the mold at temperatures of 280-380 degrees F for five to twenty minutes depending on the compound. Once fully cured, the cores are removed from the mold cavities and prepared for application of a cover.

In one preferred embodiment, the golf ball core 2 is made of a solid rubber composition comprising a polybutadiene rubber center of a composition typical to the industry. Specifically, the rubber may be 90-100 PHR polybutadiene, 0-10 PHR polyisoprene, 20-40 PHR zinc diacrylate, 3-10 PHR zinc oxide, 8-40 PHR fillers,

process aids and antioxidants, and 0.5-5 PHR peroxide initiator. In the preferred embodiment, the diameter of the solid rubber core 2 is about 1.540 ±0.005". The core 2 weighs about 36.00 ±0.50 grams, and has a PGA compression of about 70 ± 7. The solid rubber core may acceptably range from 1.45 to 1.60 inches, have a core weight range of 32 to 40 grams.

As is well known in the art, the type and amount of crosslinking agents used to make the core will have the greatest influence on the core compression achieved. To prepare the core 2 according to the preferred embodiment, it has been found that a core composed primarily of high-cis polybutadiene in combination with cross-linking agents, activators, initiators and fillers (active and inactive), can be used to achieve a golf ball core having the desired compression characteristics. As used herein, high-cis means a cis isomer content of greater than 93%. It is to be understood that the core formula set forth herein is but one formula that can be used to make a core having the desired core compression.

Once formed, the solid rubber core 2 is then subjected to a conventional molding process whereby the polymer cover 4 is injection or compression molded around the core 2 in a manner well known to those skilled in the art. To make the cover, the blended components of the cover are injection molded into cavities, which contain cores suspended in the center of the cavities. The inner surfaces of the cavities are constructed with dimple-shaped projections, which form the dimples in the cover. The process used to make the cover is the standard process used and well known in the art wherein one or more components are added together to form a blend, which is then injected into the mold. After

molding, the golf balls produced may undergo further processing steps such as pressure blasting, vibratory finishing, stamping of the logo, application of a primer, and finally, application of a top coat.

In one preferred embodiment, the cover has a thickness of about 0.070" leading to provide a total diameter of core and cover of 1.680", the commercial ball diameter standard specified by the United States Golf Association. The cover may range in thickness from 0.020 inches to 0.90 inches.

As discussed previously, the cover material is comprised of ionomer resins available from E.I. Dupont De Nemours & Co. under the name SURLYN. In the preferred embodiment, the ionomers are 70% by weight of SURLYN 8150 and 30% by weight of SURLYN 9320W. The hardness of the cover is about 60 ± 3 Shore D. An acceptable range is 30% to 90% of SURLYN 8150 blended with 10% to 50% of SURLYN 9320W.

Under the Dupont SURLYN resin classification system, the 9320W SURLYN ionomer is a soft ionomer. This very low modulus ionomer uses the zinc metal ion to neutralize the acid groups, and its acid level is about 12% by weight. Moreover, the 9320W SURLYN grade is copolymerized with n-butyl acrylate. Finally, the 9320W SURLYN resin has a melt index of about 1.0. If SURLYN 9320W is not commercially available then a similar performing olefin based copolymer can be substituted. An acceptable substitute would have a melt index of about 0.2 to 2.0 g/10 minutes.

The 8150 SURLYN resin is classified as an improved-flow ionomer, which has a high acid level of about 19 % by weight, which in turn produces a resin

characterized by a high stiffness level. The 8150 SURLYN resin uses the sodium ion to neutralize the acid groups. Finally, the 8150 SURLYN resin has a melt index of about 4.5. If SURLYN 8150 is not available commercially then any similarly performing olefin copolymer can be substituted. The 8150 substitute may have a melt index range of 2.0 to 10.0 grams/10 minutes.

In addition to the SURLYN resins, the cover composition contains color concentrate for coloring the golf ball in an amount well known to those skilled in the art.

Turning now to the dimple technology employed in the instant invention, as stated previously, the preferred geometry is a dodecahedron. Accordingly, the scope of this invention provides a golf ball mold whose molding surface contains a uniform pattern to give the golf ball a dimple configuration superior to those of the art. The invention is preferably described in terms of the golf ball that results from the mold, but could be described within the scope of this invention in terms of the mold structure that produces a golf ball.

To assist in locating the dimples on the golf ball, the golf ball of this invention has its outer spherical surface partitioned by the projection of a plurality of polygonal configurations onto the outer surface. That is, the formation or division that results from a particular arrangement of different polygons on the outer surface of a golf ball is referred to herein as a "plurality of polygonal configurations." A view of one side of a golf ball 5 showing a preferred division of the golf ball's outer surface 7 is illustrated in Fig. 2.

In Figure 3 of the preferred embodiment, a polygonal configuration known as a dodecahedron is projected onto the surface of a sphere. A dodecahedron is a type of polyhedron, which contains twelve (12) polyhedra. The term "dodecahedron" means a twelve (12) sided polyhedron. The dodecahedron of the preferred embodiment is comprised of, twelve (12) pentagons 22, which is then subdivided into sixty (60) triangles 14. It has a uniform pattern of pentagons with each pentagon subdivided into triangles and then rows.

As shown in the planar view in Figure 4, the outer surface of the ball is further defined by a pair of poles and an uninterrupted equatorial great circle path around the surface. A great circle path is defined by the intersection between the spherical surface and a plane that passes through the center of the sphere. There are ten uninterrupted great circle paths 13 on the surface of the golf ball in the preferred embodiment one of which corresponds to the mold parting line. The uninterrupted great circle path is uninterrupted as a result of being free of dimples. The mold parting line is located from the poles in substantially the same manner as the equator of the earth is located from the north and south poles.

There are ten uninterrupted great circle paths 13 on the surface of the golf ball in the preferred embodiment, which further defines the surface of the golf ball. Every uninterrupted great circle path 13 defines one side of three smaller pentagons 25 made up of five dimples 60 inside of pentagon 22 that makes up the dodecahedron, as displayed in figure 5. In addition, at every edge 14 or side midpoint A of the pentagon 22, two uninterrupted great circle paths 13 intersect.

Referring to Fig. 6 & 7, the poles 70 are located at the vertices of three pentagons 22 on the top and three pentagons 22 on the bottom side of the ball, as illustrated in this view of one such side. The mold parting line 30 is at the outer edge of the circle in this planar view of figure 7 of the golf ball.

Referring to Fig. 8, each of the twelve pentagons 22 established by the projection of the dodecahedron onto the outer ball surface 5, is further subdivided into five similar triangles 23. Within triangle 23, there are five dimples 58, two dimples 59, and two dimples 60. Each row can be described as having (R+1) dimples, where R is the row designation. Row three contains two dimples 58, and two dimples 59. Row two contains three dimples 58. Row one contains two dimples 60. The seam line 12 intersects six of the pentagons 22.

Dimple size is measured by a diameter and depth generally according to the teachings of U.S. Patent No. 4,936,587 (the '587 patent), which is included herein by reference thereto.

In Figure 9, illustrates an exception to the teaching of the '587 patent is the measurement of the depth, which is discussed below. A cross-sectional view through a typical dimple 6 is illustrated in Fig. 7. The diameter Dd used herein is defined as the distance from edge E to edge F of the dimple. Edges are constructed in this cross-sectional view of the dimple by having a periphery 50 and a continuation thereof 51 of the dimple 6. The periphery and its continuation are substantially a smooth surface of a sphere. An arc 52 is inset about 0.003 inches below curve 50-51-50 and intersects the dimple at point E' and F'. Tangents 53 and 53' are tangent to the dimple 6 at points E' and F' respectively

and intersect periphery continuation 51 at edges E and F respectively. The exception to the teaching of '587 noted above is that the depth d is defined herein to be the distance from the chord 55 between edges E an F of the dimple 6 to the deepest part of the dimple cross sectional surface 6 (a), rather than a continuation of the periphery 51 of an outer surface 50 of the golf ball.

In the preferred embodiment, dimples 58, 59, and 60 are dual radius in nature. As seen in Figure 5, dimples 58 have a diameter Dd of 0.1535" and may range from 0.15 to 0.16 inches and a corresponding depth d of 0.0062", which may range from 0.005 to 0.007" (as measured from the cord 55 to the bottom of dimple 54).Dimples 59 have a diameter Dd of 0.1457" , which may range from 0.13 to 0.15 inches, and a corresponding depth d of 0.0062", which may range from 0.005 to 0.007" (as measured from the cord 55 to the bottom of dimple 54). Dimples 60 have a diameter Dd of 0.1248" , which may range from 0.1 to 0.3 inches, and a corresponding depth d of 0.0062" and 0.005 to 0.007 inches (as measured from the cord 55 to the bottom of dimple 54). All dimples on the ball may range in diameter from 0.075 to 0.25 inches and may range in depth from 0.0025 to 0.0125 inches.

In the preferred embodiment the golf ball cover is defined by the strategic placement of 360 dimples over the surface of the ball. The size and placement dimples of the ball are defined by their numbers and their diameters.

As shown in Figure 10, a single radius dimple is defined as having one radius that defines the profile of the dimple. A dual radius dimple has two radii that define the dimple profile. For dimples 58, 59, and 60, R1 is 0.7874" , which may range from 0.5 to 0.9 inches and R2 is 0.1181", which may range from 0.9 to 1.3

inches. A major radius (Radius 1) describes the bottom of the dimple (i.e. it governs the shape of the dimple toward the bottom of the dimple). A minor radius (Radius 2) governs the shape of the dimple about its circumference. As noted below, in some embodiments, these radii may be equal. R1 defines the "bottom" portion of the dimple, R2 defines the "side" portion of the dimple.

The preferred embodiment of the present invention is further defined by the presence of bald patches upon the ball surface. In the preferred embodiment there are 30 bald patches evenly disposed over the surface of the golf ball. The bald patches are located at the midpoints of the sides of all the pentagons projected onto the surface. At that midpoint, any two uninterrupted great circle paths intersect.

The bald patches can be further defined by their geometric shape. The bald patches are rectangular in shape and are determined by the mean dimple diameter of the golf ball. The rectangle has a width of at least half the mean dimple diameter and an area of more than eight times the mean dimple area. Preferably the width of the rectangle is at least three quarters of the mean dimple diameter, while the rectangle is at least four times the mean dimple diameter

Dimples are placed on the outer surface of the golf ball based on segments of the plurality of polygonal configurations described above. In the preferred embodiment, thirty (30) dimples are associated with each pentagon. The term "associated" as used herein in relation to the dimples and the polyhedra means that the polyhedra are used as a guide for placing the dimples.

In one preferred embodiment, there are a total of 360 dimples. Advantageously, this decrease in the number of dimples when compared to prior art

golf balls results in a geometrical configuration that contributes to the aerodynamic stability of the instant golf ball. Aerodynamic stability is reflected in greater control over the movement of the instant golf ball.

Advantageously, the use of dimples that are dual radius in cross section improves the performance of the instant golf ball with respect to both distance and control of the movement of the golf ball. The presence of dual radius dimples allows for a soft trajectory in golf ball's flight. In turn, this soft trajectory leads to a soft entry of the golf ball onto the golf course green, which in turn results in greater control over the movement of the instant golf ball.

The following examples are provided to illustrate and further explain the beneficial effects of the ball described above. These examples are set forth for the purposes of illustrating the advantages obtained with the combination of the core compression, core size, cover composition, cover hardness, cover thickness, dimple configuration, and dimple number that will produce a ball that will travel the greatest distance without compromising shot-making feel.

It will be appreciated that the instant specification and claims are set forth by way of illustration and do not depart from the spirit and scope of the instant invention. It is to be understood that the instant invention is by no means limited to the particular embodiments herein disclosed, but also comprises any modifications or equivalents within the scope of the claims.

Having thus described my invention, what I claim as new and desire to secure by United States Letters Patent